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(54) **Apparatuses for introducing gases into liquids**

(57) An apparatus for introducing gases into liquids, for instance for aerating sewage water in a container, comprises a liquid duct 1 which communicates with a circulation pump, a duct 2 which guides oxydising gases such as air, and outlet nozzles 7 for expelling the liquid/gas mixture into the container. Tubes 3 are connected to radial openings of the liquid duct and pass through the gas duct. The tubes have nozzle-like constrictions in their portions disposed within the gas duct and suction openings 6 for the gas distributed over their periphery. The tubes further have, at their free ends, the outlet nozzles 7 for expelling the gas/liquid mixture produced within the gas duct.

FIG. 1

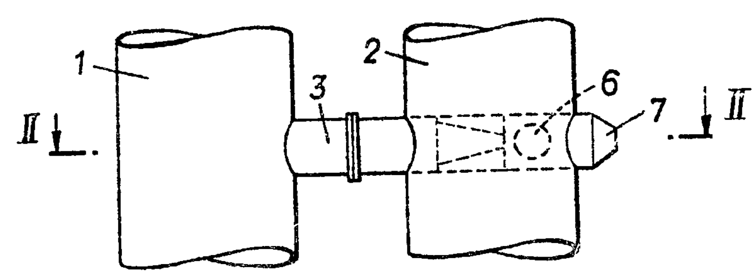

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FIG. 1

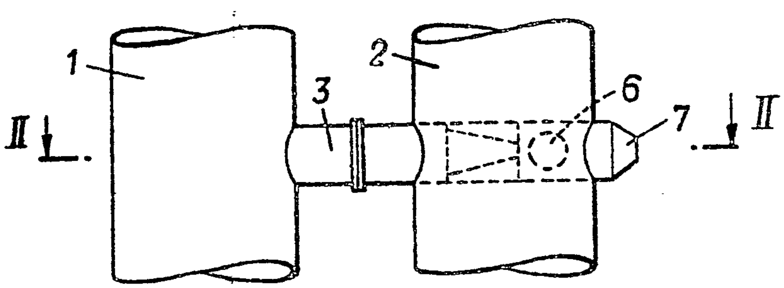


FIG. 2

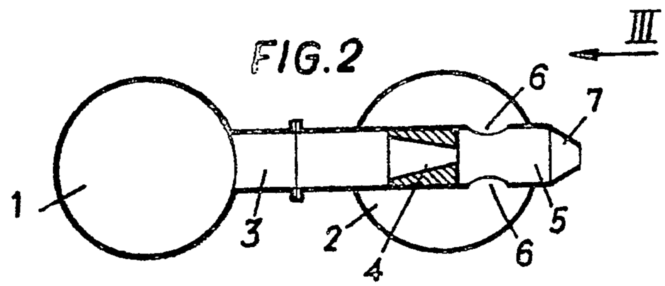


FIG. 3

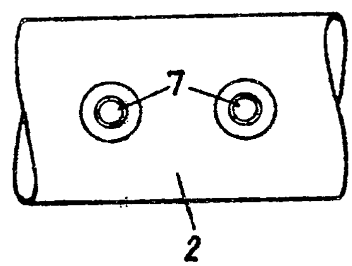


FIG. 4

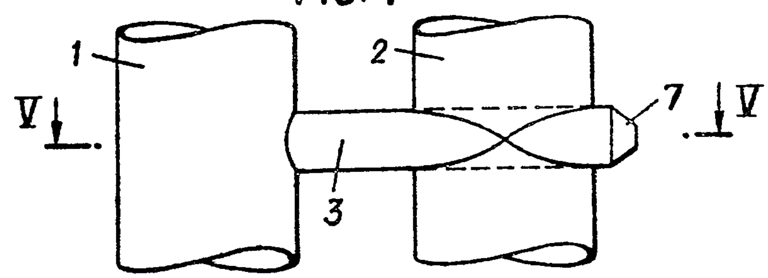


FIG. 5

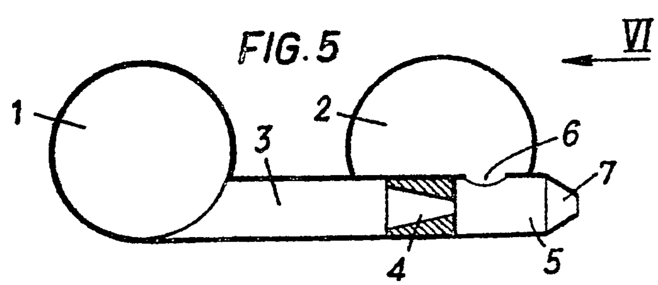


FIG. 6

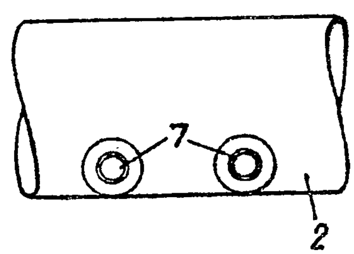


FIG. 7

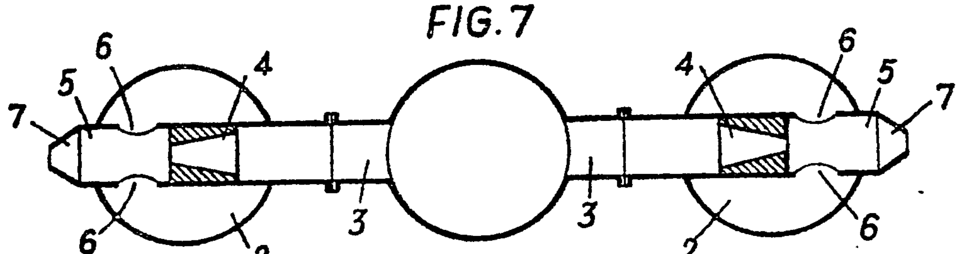


FIG. 8

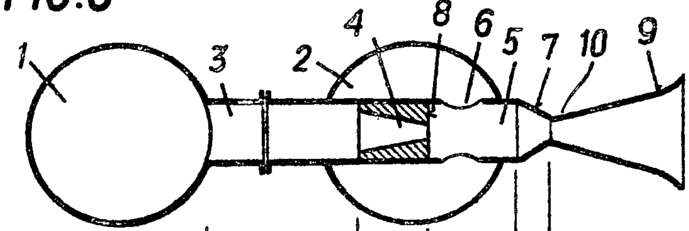


FIG. 9

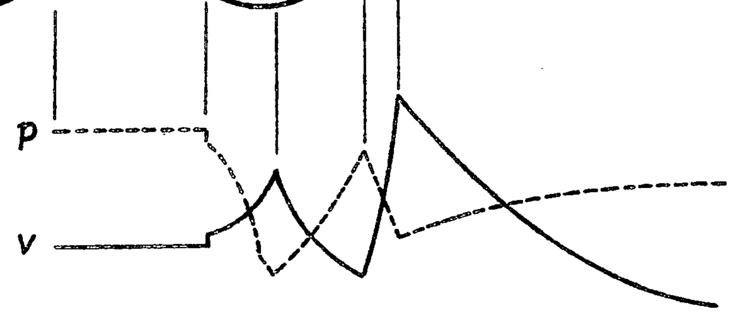


FIG. 10

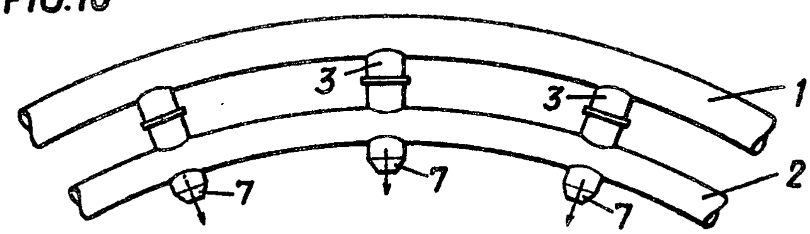


FIG. 11

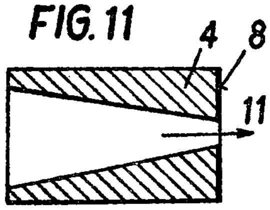


FIG. 12

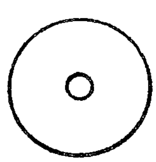


FIG. 13

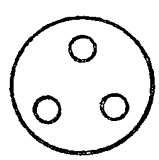


FIG. 14

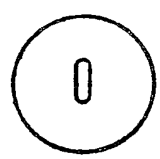


FIG. 15

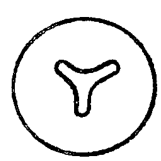


FIG. 16

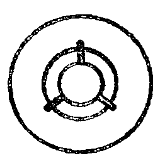


FIG. 17

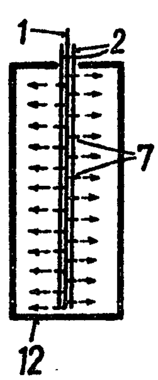


FIG. 18

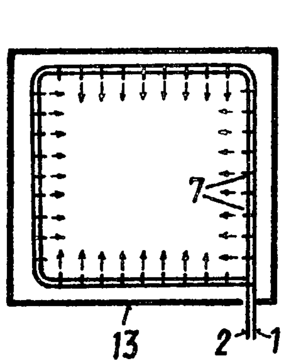


FIG. 19

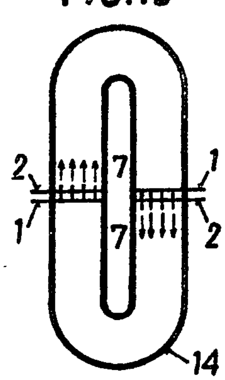
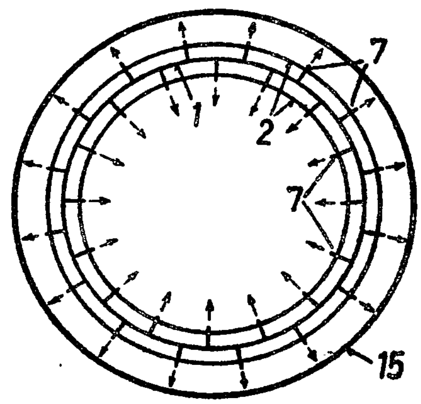


FIG. 20



SPECIFICATION

Improvements in or relating to apparatuses for introducing gases into liquids

The invention relates to an apparatus for introducing gases into liquids. Such an apparatus may be used for aerating sewage water in a container and may include a liquid duct which is connected to a circulation pump, a duct which guides oxydising gases, such as air, a mixing chamber for mixing the liquid with the gas, and outlet nozzles for expelling the liquid /air mixture into the container. It is fre quently found necessary, in the treatment of water and sewage water, to dissolve air, oxygen-containing gas mixtures, or gaseous oxygen, in water, so as to thereby enable chemical or biochemical oxydation processes to be carried out in the substances contained in the aqueous phase. The so-called activated sludge process has assumed particular importance in the treatment of sewage water. The bacteria used for the biological breakdown of the water will carry out their cleaning action most favourably if the greatest possible quantity of oxygen is supplied to them, as this oxygen is necessary for the survival of the bacteria.

It has already been proposed, for introducing gases into water, to introduce these gases into the water through a porous body. When the stream of air exits under the water surface, this stream of air is broken up into small bubbles and a very large interface is formed between the gas phase and the liquid phase. However, due to the resistance to flow presented by these porous bodies, a large expenditure of energy is required for introducing the gases into the water. It has already been proposed, for improving the intermixing of the gas and liquid phases, to use rotating aerating rollers or centrifugal aerating devices; however, a relatively high energy expenditure is also required for these methods. Also, machine parts which rotate under water present problems of wear.

Other known proposals, especially for treating the sewage water with gas, entail treating with the gas by an injector. These are methods which bring together the liquid and the gas, through mixing chambers or nozzles, using the injection principle.

According to the invention, there is provided an apparatus for introducing gases into liquids, comprising a liquid duct for communicating with a circulation pump, a duct for guiding oxydising gas, and outlet nozzles for expelling the liquid/gas mixture into the container, there being provided tubes connected to radial openings of the liquid duct and passing through the gas duct, the tubes having nozzle-like constrictions in the portions thereof within the gas duct and openings for the gas distributed over their periphery, and being provided at the free ends thereof with the outlet nozzles for expelling the gas/liquid mixture produced within the gas duct.

The fact that tubes are connected to radial openings of the liquid duct permits simple assembly. For example, parts can be assembled together simply by inserting one part in the other. By virtue of the fact that these tubes pass through the gas duct and comprise, within their area lying within the gas duct, nozzle-like constrictions, and have suction openings for the gas which are distributed round their periphery, the requirement for a separate mixing chamber is dispensed with, and the further advantage is achieved that the tubes can be simply inserted through the corresponding openings of the gas duct. Due to the provision of the nozzle-like constrictions in the tubes, gas is inwardly sucked by injector action, and the gas/water mixture thus formed can be expelled into the sewage water to be cleaned. In this way, a rapid and thorough intermixing of the liquid and gas phases is accomplished. The duct which guides the gas can be subject to atmospheric pressure or to a pressure higher than atmospheric. The gas/air mixture produced inside the gas duct can be expelled into the container by way of outlet nozzles provided at the free end of the tubes. Due to the combination of these features, there is created a simple apparatus by means of which it is possible to accommodate optimally to the particular shapes and dimensions of the sewage water container occurring in each individual case, and to work with a small number of different components.

Preferred apparatus enables a large number of debouchment points to be provided within the container, through which debouchment points the gas/water mixture can be expelled into the aqueous phase. In this way, it becomes possible, with simple means, to achieve a uniform and complete intermixing of the whole contents of the container. The liquid and gas ducts can, for example, be constituted by plastics tubes or by metal tubes. In each of these examples, the radial openings can be produced simply, for example by drilling them in the tubes.

The edge or periphery of the free opening of the nozzle-like constrictions is preferably larger for the cross-sectional area thereof than the circumference of a circular cross-section of the same cross-sectional area. In this way, the surface of the liquid stream is increased and, as the gases are dissolved in the liquids in proportion to the gas pressure present and in proportion to the gas pressure present and in proportion to the surface of the liquid, the process of intermixture of the gas and liquid phase with each other is carried out very thoroughly. Thus, the cross-section of the nozzle-like constrictions should deviate from circular cross-section, and the nozzle like constrictions may have elongate cross-section, be con-

stituted as an annular nozzle, or as a multi-hole nozzle; common to all these embodiments of the nozzle-like constrictions is the fact that they result in a relatively large surface area of the stream of water.

The form of construction selected is preferably such that the inner wall of the nozzle-like constrictions comprises flow guidance surfaces, particularly grooves, which preferably proceed helically. Provision of these flow guidance surfaces imparts additional turbulence to the water, so that a better intermixing of the pases can be achieved.

A respective diffuser may be connected to each outlet nozzle of the tubes, and openings may be provided at the point of interconnection between the diffusers and the outlet nozzles. In this way further gas or chemicals can be added to the mixed phase stream in a simple way.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a preferred embodiment;

Figure 2 is a cross-section, taken along the line II—II of Fig. 1;

Figure 3 shows an elevation of the embodiment shown in Fig. 1 as viewed in the direction of arrow III of Fig. 2;

Figure 4 is a plan view of another preferred embodiment;

Figure 5 is a cross-section taken along line V—V of Fig. 4;

Figure 6 is an elevational view, as seen in the direction of arrow VI of Fig. 5;

Figure 7 is a cross-sectional view, similar to those shown in Figs. 2 and 5, of a further preferred embodiment ;

Figure 8 is a view of yet another preferred apparatus, this view being similar to that of Fig. 2 but including a diffuser;

Figure 9 is a diagram illustrating the relationship between pressure and speed in operation of the apparatus shown in Fig. 8;

Figure 10 is a detail of a preferred apparatus having curved air and water tubes;

Figure 11 is a longitudinal cross-section through a water nozzle;

Figures 12—16 illustrate different cross-sections which can be given to the water nozzle; and

Figures 17—20 schematically illustrate different ways of arranging the preferred apparatus in various containers.

As shown in Figs. 1—3, a pressurized water duct is constituted by a tube 1 and a gas duct by a tube 2. Radially connected to the water tube 1 are a number of tubes 3 which, as shown in Fig. 2, comprise a water nozzle 4 which constitutes the nozzle-like constriction. The tube 3 comprises, inside the gas-guiding tubes 2, openings which are distributed around the periphery of the tubes 3. The stream issuing from the water nozzle 4 in the mixing chamber 5 sucks gas from the gas guiding duct 2, and the gas thus inwardly sucked is mixed with the liquid phase in the mixing chamber 5 lying within the tube 3. The gas/water mixture is forced through an outlet nozzle 7 into the interior of the container, the water being forced into the water tubes 1 by a pump (not shown). The embodiment shown in Figs. 4 to 6 has openings serving to suck water from the tubes 2; these openings are only provided over part of the surface of the tube 3 and are disposed after the water nozzle 4 in the direction of flow. The tube 3 passes substantially tangentially through the gas tube 2, and the gas/water mixture formed is, again, expelled through the outlet nozzle 7 into the container. In the embodiment of Fig. 7 two tubes 3 communicate with a water tube 1. Each of these tubes 3 passes through an air tube 2 and, in the interior of this air tube 2, has suction openings 6 for the air. In this embodiment, the arrangement is such that the tubes 3 include an angle of 180° with each other. However, it is entirely feasible to select any desired angle between the two mixture tubes, and in this way to accommodate to the geometrical conditions in the sewage container. As the tubes 1 and 2 are made of conventional metal or plastics material, these tubes may be composed in any desired way and extend over long distances of the sewage container.

The manner of operation of the preferred apparatus will be explained in detail with reference to Figs. 8 and 9. The sewage water conveyed by a pump into the tube 1 has a certain pressure and a certain speed of flow at the point of interconnection with the mixing tube 3. As shown in Fig. 9, when the water flows through the water nozzle 4 its pressure decreases and its speed of flow increases. The stream of water arrives at high speed and low pressure to the area of the air inlet openings 6 of the tube, and is mixed with the inwardly sucked air within the mixing chamber 5. In this mixing chamber 5, an increase in pressure and a simultaneous decrease in the speed of flow can be observed. This increase in pressure results in an improved solubility of the air in the water, as the solubility of a gas in a liquid principally depends on the pressure and on the interface surface of the two phases. The mixing chamber 5 is delimited on one side by the end surface 8 of the water nozzle and at the other side by the mouth of the outlet nozzle 7. In the embodiment illustrated in Fig. 8 the air water mixture passes, by way of the outlet nozzle 7, into a diffuser 9. As is illustrated in Fig. 9 and conditioned by the tapering cross-section of the outlet nozzle, a pressure decrease and an increase in the speed of outflow is again observed. In the diffuser 9 the speed again decreases and the pressure increases. Therefore, in this zone, a greater part of the oxygen, which has not yet

dissolved, becomes dissolved in the water, in accordance with an increasing partial pressure in the gas phase. Consequently, the effect of the mixing chamber 5 can be further improved by the provision of a diffuser of this kind. Further openings 10 can be provided in the immediate vicinity of the point of connection between diffuser 9 and the outlet nozzle 7; further gas or chemicals can be added to the mixed flow by way of these further openings 10. Analagously to the openings 6, these openings 10 may be arranged within another air duct.

In the preferred apparatus, the air in the tube 2 may be subject to atmospheric pressure or to a pressure higher than atmospheric. It goes without saying that the solubility of the gas phase in the liquid increases with increasing pressure in the air duct.

Fig. 10 shows two concentrically extending ducts 1 and 2. Tubes 3 extend radially from the water-guiding duct 1 towards the centre of curvature of the tubes and pass through the air guiding tube 2. The outlet nozzles 7 are also radially directed, and the arrangement may be either similar to that shown in Figs. 1 to 3 or to that shown in Figs. 4 to 6.

Fig. 11 is a longitudinal cross-section taken through a water nozzle 4, in which the direction of flow is indicated by arrow 11. Figs. 12 to 16 are elevational views of a water nozzle 4 of this kind, viewed in the direction of the end surface 8. Fig. 12 shows a nozzle having a circular cross-section, while Fig. 13 illustrates a multi-hole nozzle, which provides a substantially improved intermixing of the gas and liquid phases in comparison with a circular cross-section because the surface of the stream of liquid in contact with the gas phase is increased in relation to the cross-section. Other advantageous formations of the cross-sections of the water nozzle 4 lead to a further increase in the surface of the stream of liquid in relation to the cross-section of the nozzle opening. Thus, Fig. 14 shows a slot-shaped nozzle opening; Fig. 15 shows a nozzle opening cross-section which substantially consists of three prongs; and Fig. 16 shows a nozzle opening cross-section which is ring shaped.

Figs. 17 to 20 schematically illustrate different arrangements, shown by way of example, of the preferred apparatus within containers of differing shape. Again, 1 designates the water guiding ducts and 2 the air guiding ducts; in Fig. 17 the container is designated as 12. The outlet nozzles of the mixed phase stream are indicated at 7. Figure 18 illustrates a container 13 having square shape as viewed in plan, the water tube 1 and also the air tube 1 following the contour of this container 13. Fig. 19 illustrates a container whose cross-section corresponds to an oval ring. The arrangement of the water and air tubes is such that a direction of flow along the ring-shaped cross-section is achieved by the mixed phase streams leaving the outlet nozzles 7. Fig. 20 is a plan view of a substantially cylindrical container 15. Within the container 15 the water tubes 1 are inwardly and outwardly concentrically surrounded by the air tubes 2, and the direction of flow of the mixed phase streams, which leave the outlet nozzles, is alternately radially inwards and radially outwards.

The arrangement of the tubes relative to one another may also be such that, in each case, water tubes and air tubes are arranged one above the other in the axial direction of the container, the tubes which lead away from the water tubes and which pass through the air tubes extending substantially parallel to the container axis. If, in the case of an arrangement of this kind, the water and air tubes consist of plastics material, the arrangement may be flexible, and such a prefabricated tube system can be bent in a manner corresponding to requirements occurring in each case and for example may be placed along the container wall.

CLAIMS

1. An apparatus for introducing gases into liquids, comprising a liquid duct for communicating with a circulation pump, a duct for guiding oxydising gas, and outlet nozzles for expelling the liquid/gas mixture into the container, there being provided tubes connected to radial openings of the liquid duct and passing through the gas duct, the tubes having nozzle-like constrictions in the portions thereof within the gas duct and openings for the gas distributed over their periphery, and being provided at the free ends thereof with the outlet nozzles for expelling the gas/liquid mixture produced within the gas duct.

2. An apparatus as claimed in claim 1, in which the edge or periphery of the free opening of the nozzle-like constrictions is larger for the cross-sectional area thereof than the circumference of a circular cross-section of the same cross-sectional area.

3. An apparatus as claimed in claim 2, in which the cross-section of each nozzle-like constriction differs from circular cross-section.

4. An apparatus as claimed in claim 2, in which each nozzle-like constriction has as elongate cross-section.

5. An apparatus as claimed in claim 2, in which each nozzle-like constriction is an annular nozzle.

6. An apparatus as claimed in claim 2, in which each nozzle-like constriction is constituted as a multi-hole nozzle.

7. An apparatus as claimed in any one of claims 2 to 6, in which the inner wall of each nozzle-like constriction comprises flow guidance surfaces, in the form of grooves, which proceed in helical fashion.

8. An apparatus as claimed in any one of claims 1 to 7, in which a respective diffuser is

connected to each outlet nozzle of the tubes.

9. An apparatus as claimed in claim 8, in which openings are arranged at the point of interconnection between the diffusers and the outlet nozzles and serve for the introduction of further gas or chemicals into the mixed phase stream.

10. An apparatus for introducing gases into liquids, substantially as hereinbefore described with reference to any one of the embodiments illustrated in the accompanying drawings.

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ABSTRACT:

CHG DATE=19990617 STATUS=O> An apparatus for introducing gases into liquids, for instance for aerating sewage water in a container, comprises a liquid duct 1 which communicates with a circulation pump, a duct 2 which guides oxydising gases such as air, and outlet nozzles 7 for

expelling the liquid/gas mixture into the container. Tubes 3 are connected to radial openings of the liquid duct and pass through the gas duct. The tubes have nozzle-like constrictions in their portions disposed within the gas duct and suction openings 6 for the gas distributed over their periphery. The tubes further have, at their free ends, the outlet nozzles 7 for expelling the gas/liquid mixture produced within the gas duct.